CHEMICAL ENGINEERING 3553-1, Class Number 5133
CHEMICAL REACTION ENGINEERING
Spring Semester, 2015
C O U R S E S U M M A R Y

INSTRUCTOR:

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SCHEDULE:

MWF 11:50 AM-12:40 PM, WEB L102
Help/Discussion Section, Thursday, 1:00-2:00 PM, WEB L102 or
Help/Discussion Section, Tuesday, 9:00-10:00 AM, WEB 1250

PRE/CO-REQUISITES:

"C-" or better in CH EN 3353 (Fluids), CH EN 3453 (Heat Transfer), and CH EN 3853 (ChE Thermo). Fulfills Quantitative Intensive BS.

DESCRIPTION:

Reaction-rate equations, adiabatic reactions, back-mixed and plug-flow reactors, heterogeneous reactions, heterogeneous catalysis, reactor design.

GRADING:

3 EXAMS @20% ea.	60%
Homework	15%
Quizzes	10%
Participation in Class	15%

TEXT:

Essentials of Chemical Reaction Engineering, 1st Edition,
H. Scott Fogler, Prentice Hall, 2011.
Text Website: www.umich.edu/~essen

REQUIRED EQUIPMENT:

We will be using the U of U Clicker Technology for this class (ResponseCard NXT or ResponseWare™ by Turning Technologies). This will require you to purchase a "Clicker" from the bookstore or purchase a license from Turning Technologies. Used clickers are available from the bookstore. These are the same clickers used in seminar. However, you must register your clicker for this course in CANVAS to receive credit.

HOMEWORK:

Homework is to be scanned and uploaded to CANVAS in pdf format on the day and time that it is due. Any associated files such as Excel files, MATLAB, POLYMATH, or COMSOL files must also be uploaded for that assignment. Your last name and student ID number must be the first part of the filename.

PARTICIPATION: Participation in class will be monitored using your clicker responses to questions asked during class so no credit will be given if you forget your clicker. A point system will be established and normalized to give a final percentage for grading at the end of the semester. It is required that you bring your textbook to class as well.

IMPORTANT DATES:

Last day to drop (delete) classes (no penalty)	January 21
Last day to add classes without permission code	January 19
Last day to withdraw from term length classes	March 6

Learning Objectives:

1. Demonstrate knowledge of reactions, reaction rate expressions, stoichiometry.
2. Recognize the different types of reactors and when to use each type.
3. Calculate kinetic rate parameters from experimental data and determine their uncertainties.
4. Apply mole balances to derive and use design equations for ideal reactors.
5. Demonstrate knowledge of stoichiometry in designing ideal reactors
6. Recognize the importance of pressure drop in gas-phase packed bed reactors
7. Demonstrate knowledge of catalysis and catalytic reactors
8. Design chemical reactors that use catalysts that degrade over time
9. Demonstrate knowledge of contemporary software for solving 2D reactor problems involving multi-physics
10. Demonstrate knowledge of contemporary chemical engineering issues and controversies.

Topics Covered:

- Reactor configurations, Conversion, Isothermal Reactor design for ideal reactors
- Rate laws, elementary reactions, reversible reactions
- Stoichiometry for batch and flow systems
- Packed bed reactors (PBR), pressure drop considerations
- Unsteady state isothermal reactor design – CSTRs, PBRs
- Analysis of rate data – obtaining kinetic parameters from experimental data
- Non-isothermal Reactor design for ideal reactors
- Two-dimensional reactor design – COMSOL software, Multiple steady states
- Unsteady state non-isothermal reactor design
- Catalysis, catalysts and catalytic reactors, Catalysis deactivation
- Non-ideal Reactors – Residence time distribution

Software Used in Course:

- EXCEL, MATLAB, POLYMATH, COMSOL

Software available through remote access to ICC. See instructions http://bitly.com/YYaPlf

Nondiscrimination and Disability Access Statement:

The University of Utah is fully committed to affirmative action and to its policies of nondiscrimination and equal opportunity in all programs, activities, and employment with regard to race, color, national origin, sex, age, status as a person with a disability, religion, sexual orientation, and status as a veteran or disabled veteran. The University seeks to provide equal access to its programs, services and activities for people with disabilities. Reasonable prior notice is needed to arrange accommodations. Evidence of practices not consistent with these policies should be reported to the Office of Equal Opportunity and Affirmative Action, (801) 581-8365

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TENTATIVE COURSE OUTLINE (12/11/2014)

Text: *Essentials of Chemical Reaction Engineering*, 1st Edition, H. Scott Fogler, Prentice Hall, 2011.

Day	***Subject***	***Reading Assignment***
Jan 12	Overview, mole balances, rates of reaction	1.1-1.2
Jan 14	Mole Balances, Reactor configurations	1.3-1.5
Jan 16	Conversion, reactor design, POLYMATH	2.1-2.3
Jan 19	********** MARTIN LUTHER KING/HUMAN RIGHTS DAY**********	
Jan 21	Reactors in series **HW#1 DUE**	2.4-2.6
Jan 23	Rate laws, reaction order, rate constants -	3.1-3.2
Jan 26	Elementary reactions, reversible	3.3-3.4
Jan 28	Stoichiometry, batch, flow systems - **HW#2 DUE**	4.1-4.2
Jan 30	Reactions with volume change, equilibrium	4.2
Feb 2	Isothermal reactor design, batch	5.1-5.2
Feb 4	Reactor design – CSTR **- HW#3 DUE -**	5.3
Feb 6	Reactor design – multiple-CSTRs, Tubular Reactors	5.4
Feb 9	Tubular Reactors, pressure effects	5.5
Feb 11	Reaction with pressure drop - **HW#4 DUE**	5.5-5.6
Feb 13	Molar Flow Rate Balance Algorithm	6.1-6.2
Feb 16	**********PRESIDENTS' DAY**********	
Feb 18	Microreactors, Membrane Reactors	6.3-6.4
Feb 20	Problem Session/Review- **HW#5 DUE**	
Feb 23	********** FIRST EXAM**********	
Feb 25	Unsteady CSTR, Semibatch Reactors	6.5-6.6
Feb 27	Analysis of rate data, numerical schemes	7.1-7.3
March 2	Method of initial rates, differential reactors	7.4-7.6
March 4	Parallel/series reactions, selectivity	8.1
March 6	Strategies for different reactors - **HW#6 DUE**	8.2-8.4
March 9	Complex Reactions	8.5-8.6
March 11	Bioreactions	9.1-9.3
March 13	Bioreactors and Biosynthesis **-HW#7 DUE**	9.4
March 14-22	**********SPRING SEMESTER BREAK **********	
March 23	Bioreactors	9.4
March 25	Catalysts, catalytic reaction mechanisms	10.1-10.2
March 27	Synthesizing rate laws, Analysis of heterogeneous reactors/reaction data	10.3, 10.4
March 30	Catalyst deactivation--- **HW#8 DUE**	DVD-Chpt.10
April 1	Reactor Energy Balances, Adiabatic operation	11.1-11.3
April 3	Adiabatic operation, Heating/Cooling	11.4-11.6
April 6	Steady-State, Non-isothermal Reactor Design	12.1-12.4
April 8	Problem Session/Review - **HW#9 DUE**	
April 10	**********SECOND EXAM **********	
April 13	Multiple steady states	12.5
April 15	Non-isothermal multiple reactions, Safety	12.6-12.7
April 17	Spatial variations, COMSOL Tutorial	DVD-Chpt.15
April 20	COMSOL, **HW#10 DUE**	
April 22	Unsteady state energy balances	13.1-13.2
April 24	Unsteady CSTR, PFR, Residence time distributions, Non-ideal Reactors	13.3-13.4, DVD-13
April 27	Problem Session/Review **HW#11 DUE**	

May 4 FINAL EXAMINATION – Monday, May 4, 10:30-12:30PM, WEB Rm. L102

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References

Cutlip, Michael B. and Mordechai Shacham, "Problem Solving in Chemical and Biochemical Engineering with POLYMATH, Excel, and MATLAB," 2nd ed., Prentice Hall International Series, 2008.

Fogler, H. Scott, "Elements of Chemical Reaction Engineering," *4th Edition*, Prentice Hall International, 2005.

Levenspiel, Octave, "Chemical Reaction Engineering"*, 2nd ed.*, John Wiley & Sons, Publishers, 1972. Call no. TP157 .L4 1972

Levenspiel, Octave, "Chemical Reaction Engineering [electronic resource] *", 3rd ed., 1999, available online through library or Knovel*, *http://www.knovel.com/knovel2/Toc.jsp?BookID=2469*

Nauman, E. Bruce, "Chemical Reactor Design, Optimization, and Scaleup," 2nd edition, John Wiley & Sons, Publishers, 2008. Call no. TP157 .N393 2008